MONITORING STREAM CONNECTIVITY WITH TRAIL CAMERAS

National 303(d) Program and Data Management Workshop

Mary Becker and Melissa Czarnowski, CT DEEP Water Monitoring & Assessment Program

BACKGROUND

Monitoring stream connectivity since 2016

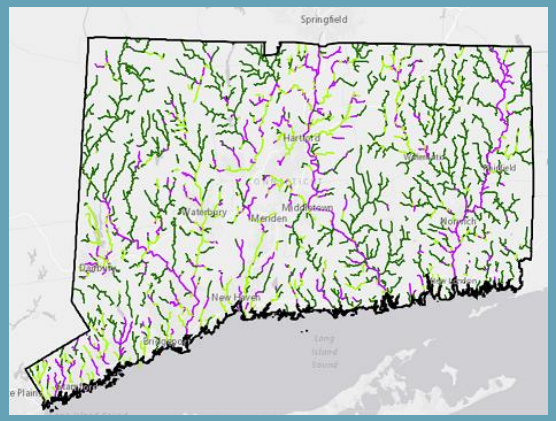
Original purpose: **monitor impacts of registered groundwater diversions**

Since evolved to also monitor:

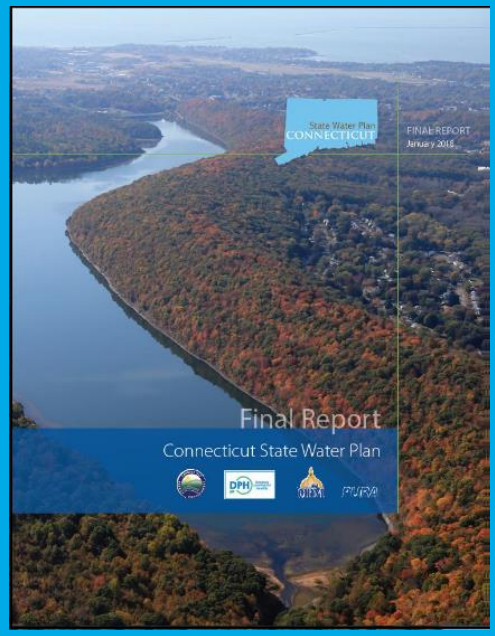
- **Regional Monitoring Network streams**
- **Headwater streams**
- **Streams downstream of dams required to make streamflow releases under the Streamflow Regulations**
- **Impacts of a hydropower facility**
- **Streams near USGS stream gages – uploading photos to Flow Photo Explorer**

BACKGROUND

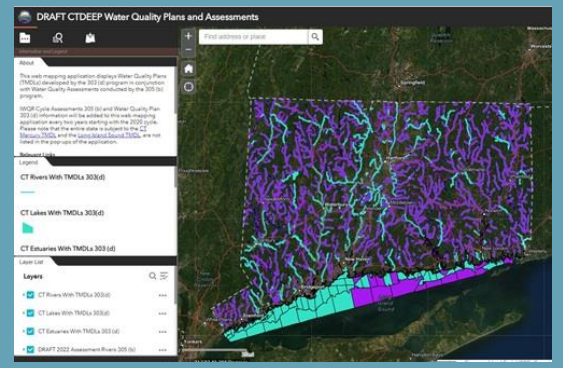
Registered Diversions



State Streamflow Regulations

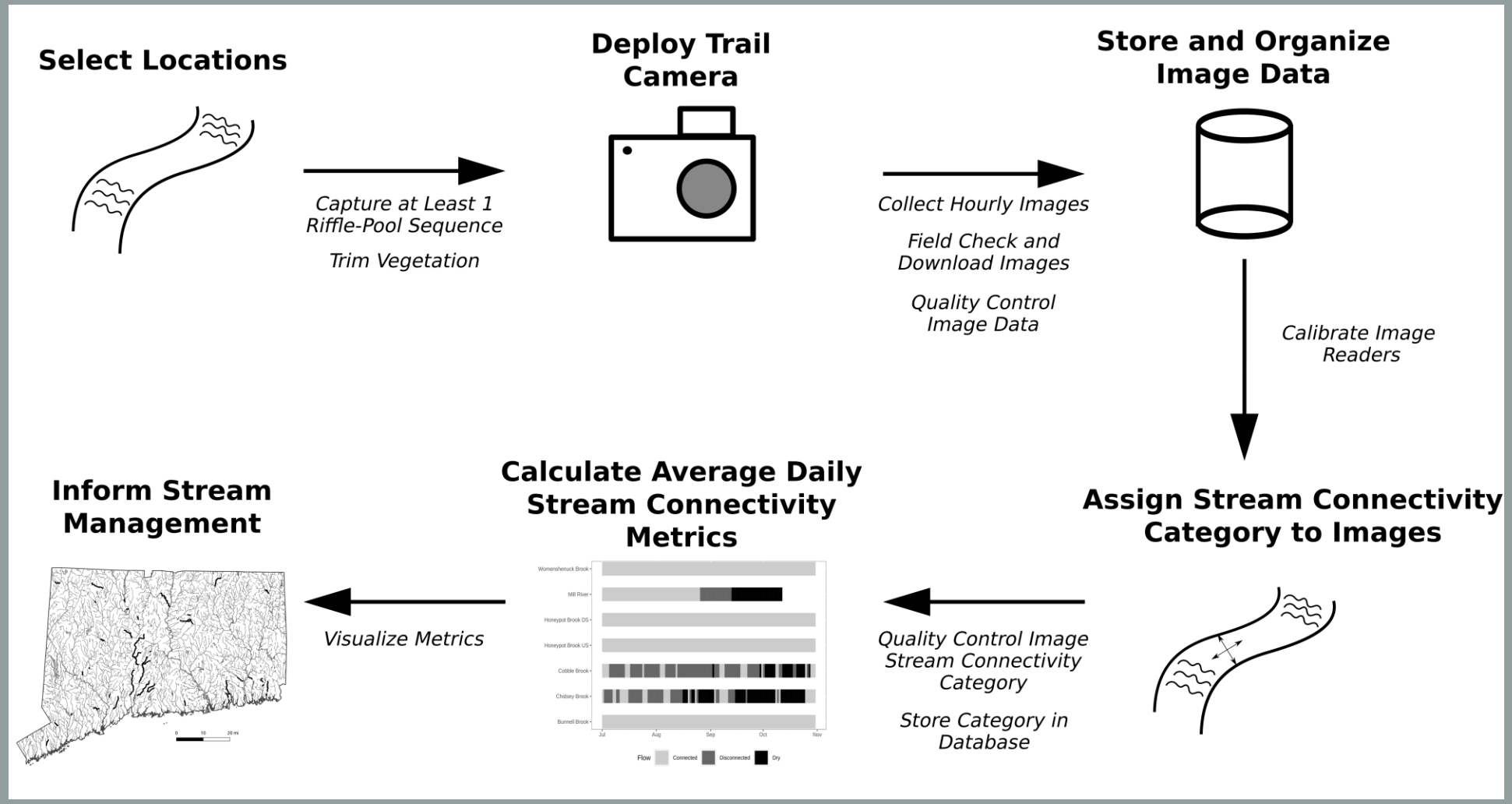


State Water Plan



Integrated Water Quality Reporting

METHOD



Bellucci, CJ, Becker, ME, Czarnowski, M, Fitting, C. A novel method to evaluate stream connectivity using trail cameras. River Res Applic. 2020; 36: 1504– 1514.

EQUIPMENT, SETTINGS, & FIELD PROTOCOLS

Reconyx Hyperfire 2 or Other Trail Camera

1 picture every hour, day only (if option is available)

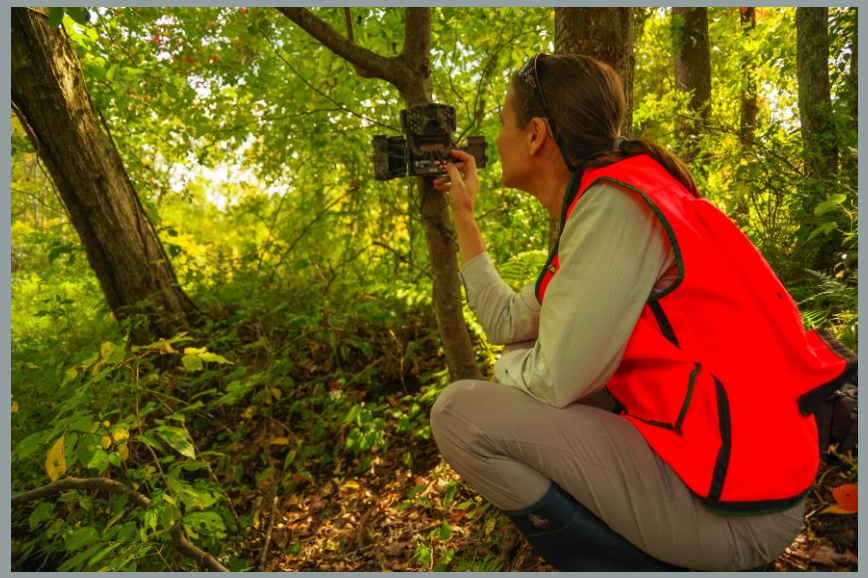
Target deployment period: July 1 through October 31 (Rearing & Growth Bioperiod)

Typically deploy in May-June and take down in November

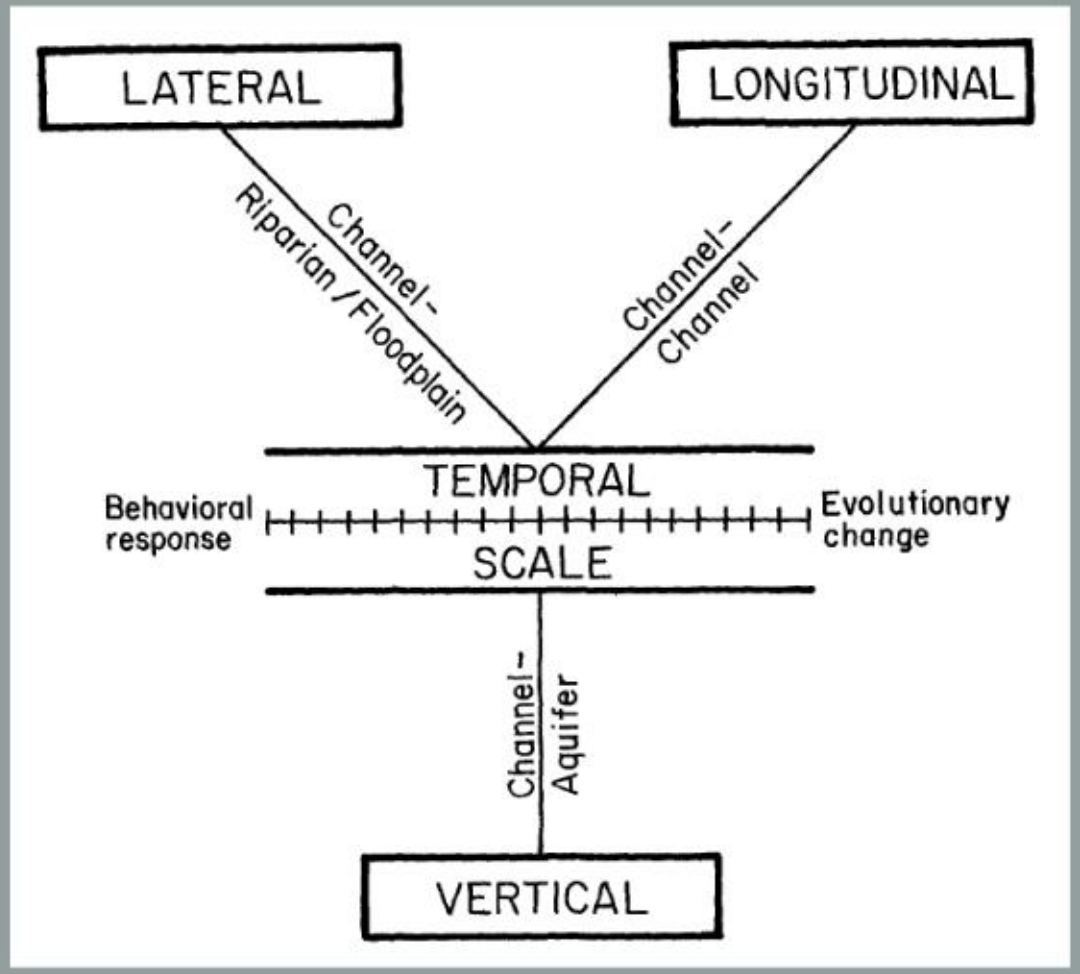
Sites near USGS gages remain up all year

Check on cameras in August

- **Make sure cameras are still taking pictures as programmed**
- **Clear any vegetation that has grown in front of camera lens**
- **Swap SD card**
- **Check batteries, replace if voltage drops below 1.50 volts**



FLOW-HABITAT CONNECTIVITY



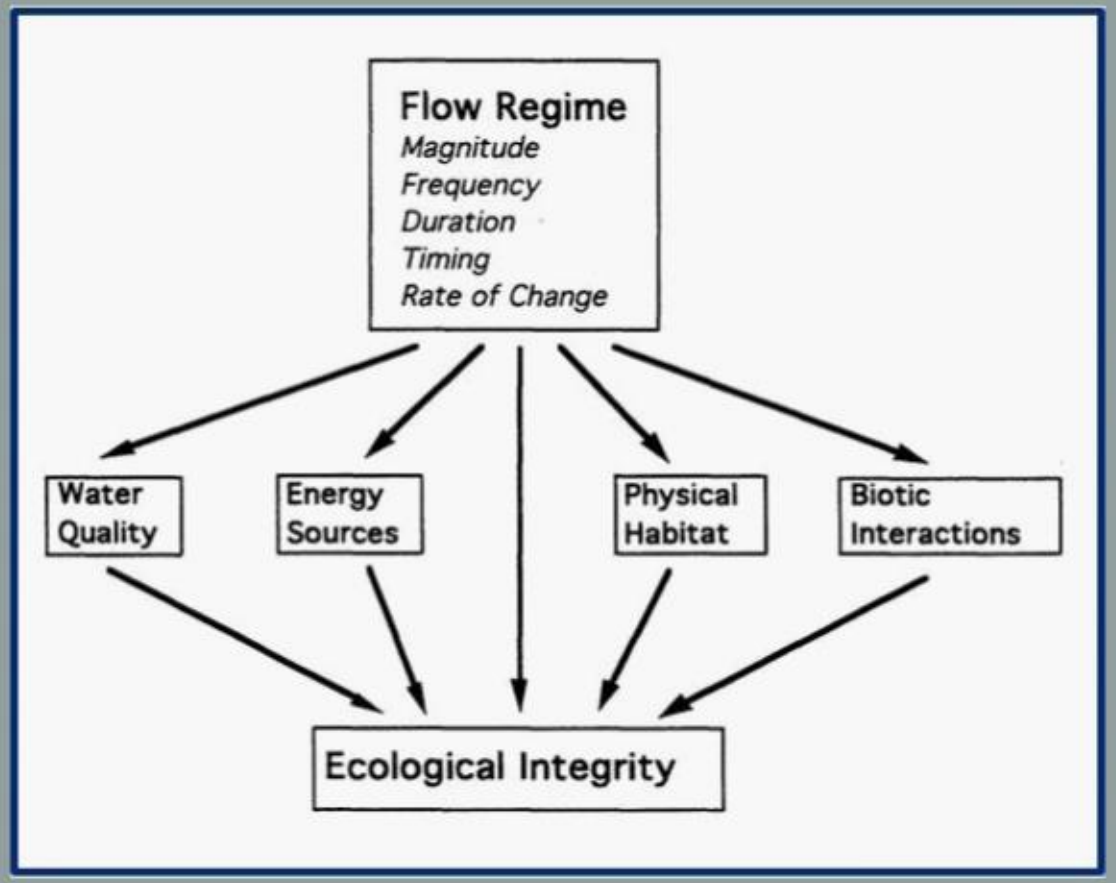
Ward, JV. 1989. The four dimensional nature of lotic ecosystems. JNABS 8:2-8.

STREAM CONNECTIVITY CATEGORIES

Disconnected

Connected

THE NATURAL FLOW REGIME



Poff, L, J. D. Allan, M. B. Bain, J. R. Karr, K. L. Prestegaard, B. D. Richter, R.E. Sparks, J. C. Stromberg. 1977. BioScience 47:11 769-784

STREAM CONNECTIVITY METRICS

DURATION

A period of time an image is associated with a category

Average number of consecutive days in category 1

FREQUENCY

How often an image is in a category

Number of days in category 1

MAGNITUDE

Provides a statistical summary of a category

Average flow category

TIMING

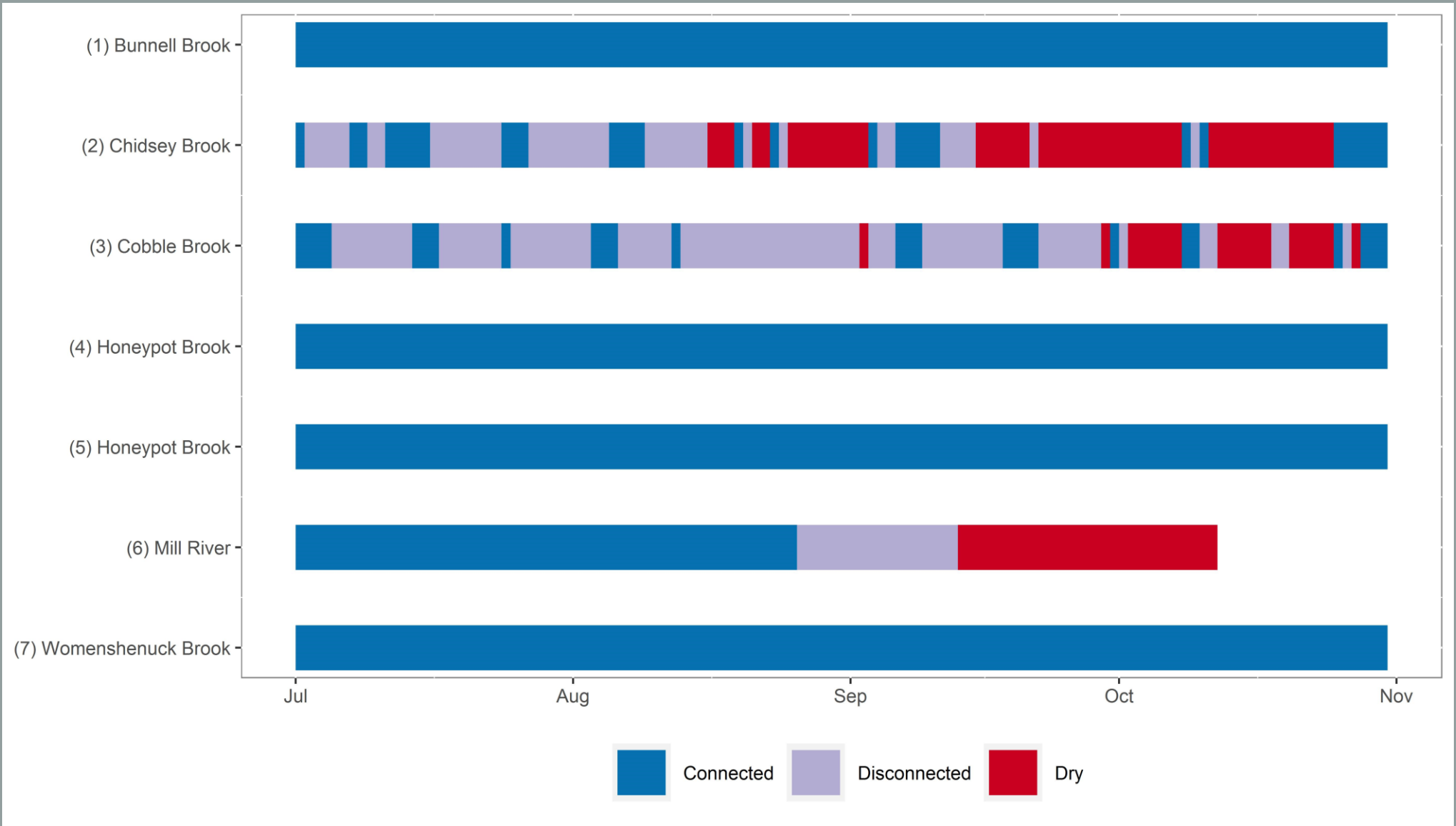
Describes when a category occurs temporally

Julian Day of 1st observation in category 1

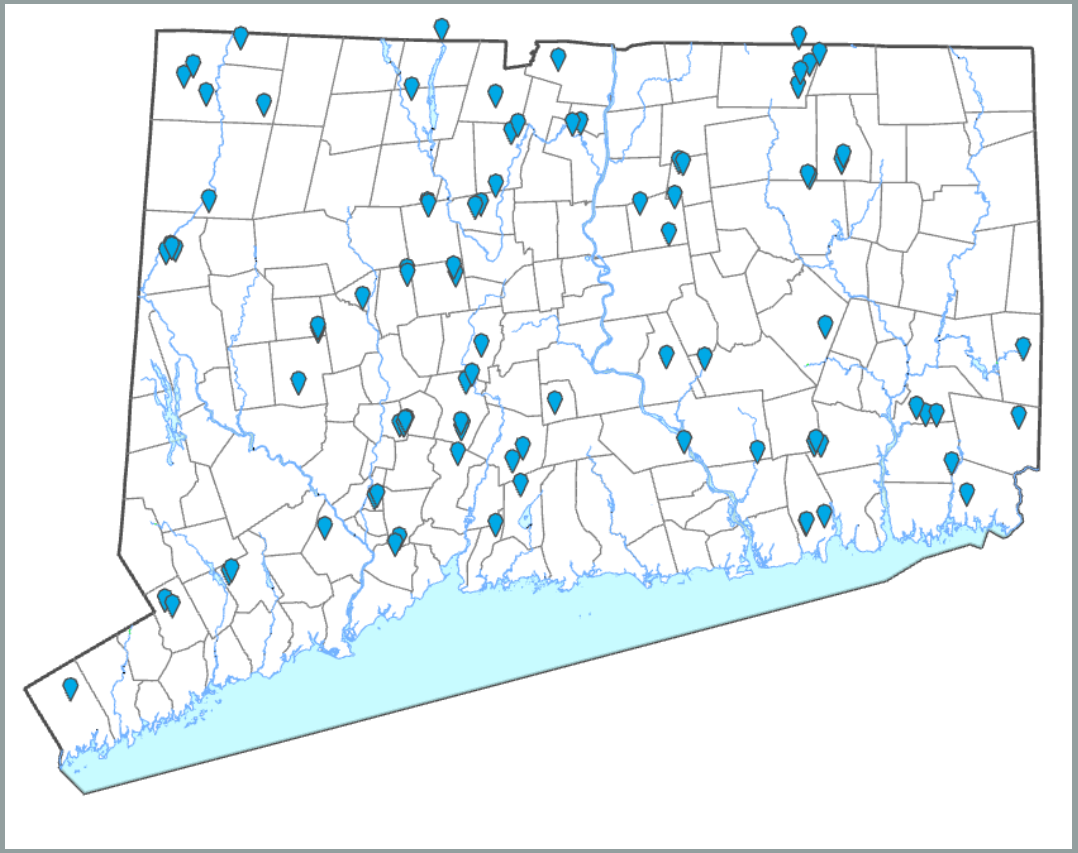
30 Stream Connectivity Metrics

https://github.com/marybecker/streamconnectivitymetrics

METRICS EXAMPLE



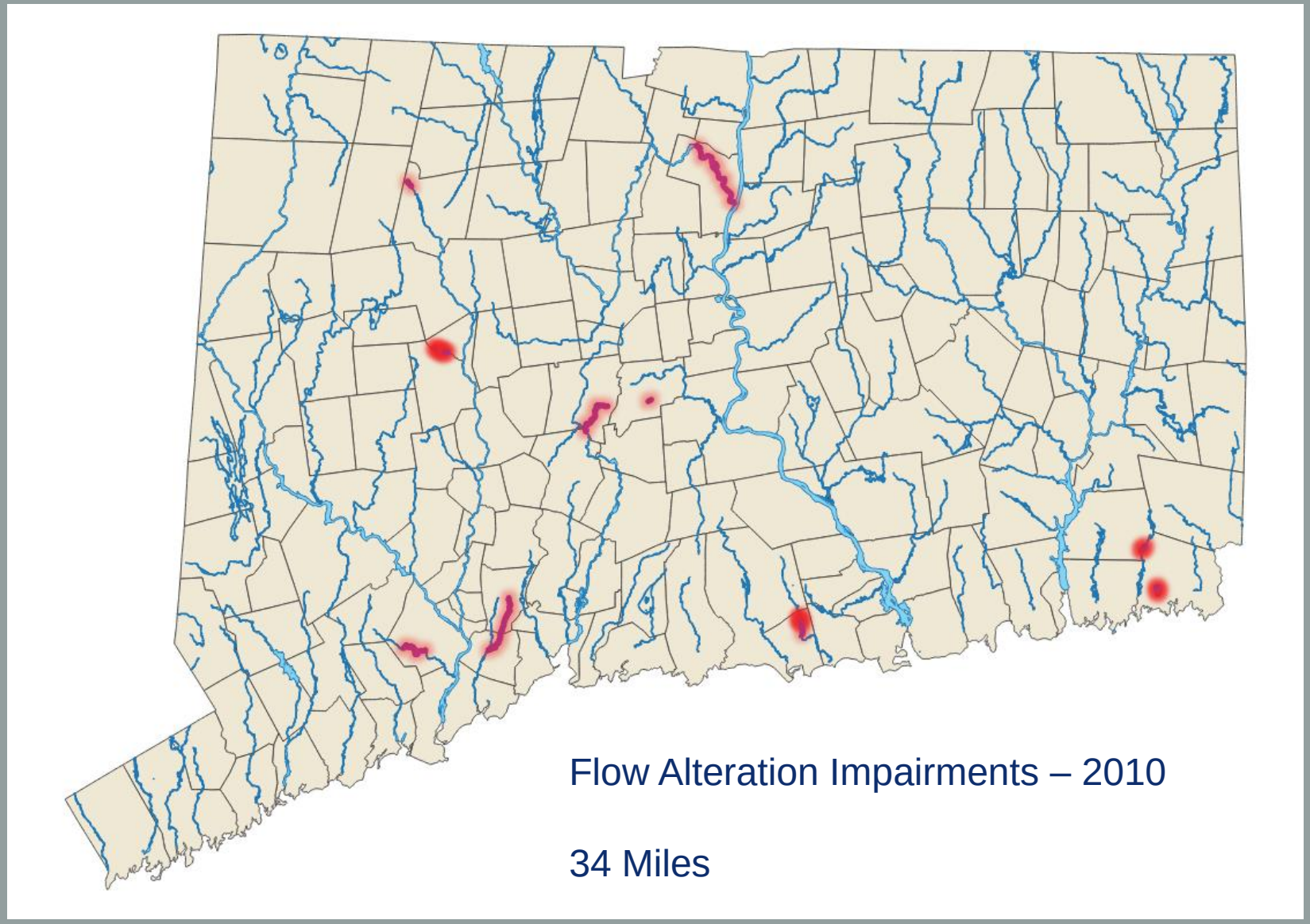
UNIVERSE OF TRAIL CAMERAS SINCE 2016



Year	# of Sites Monitored	# of Images
2016	5	1,452
2017	17	17,123
2018	25	135,065
2019	37	181,627
2020	32	184,791
2021	24	111,782
2022	21	86,172
2023	38	63,475

781,487 … and counting!

INTEGRATED WATER QUALITY REPORT



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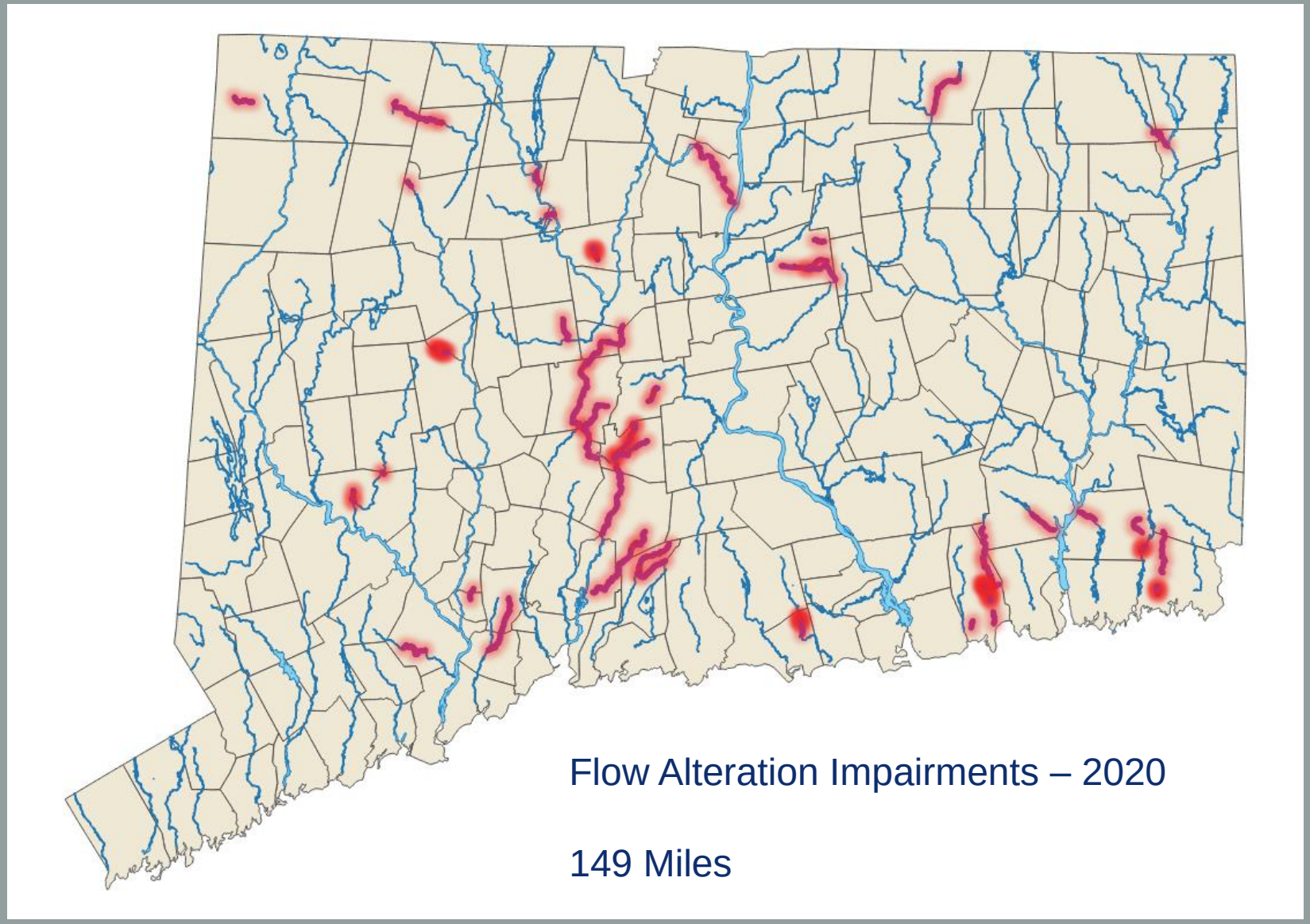


BRIDE BROOK, EAST LYME CT

Bride Brook is one of Connecticut's premier alewife migration runs.

The previous diversion permit (expired August 26, 2023) allowed a maximum withdrawal of 0.56 MGD from a well located immediately south of Bride Lake.

Bride Brook trail camera data helped build a case for more stringent permit conditions.

The new diversion permit included a requirement to install and maintain the stream gage at the proper location, monitor streamflow, and cut back pumping when streamflow is low.

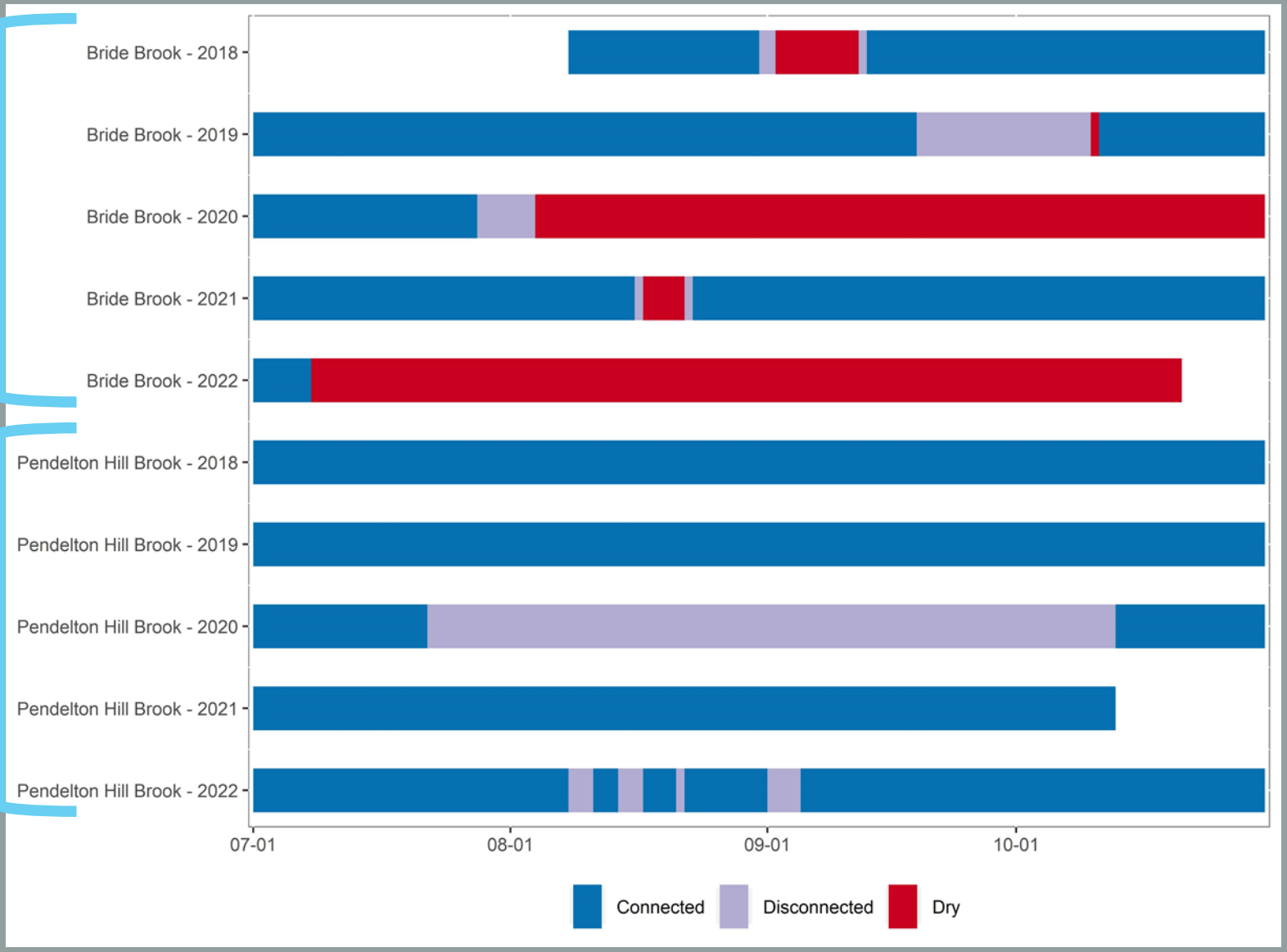
RANGE OF STREAMFLOW CONDITIONS

USGS CT Streamflow Rank (relative to previous water years)							
	2016	2017	2018	2019	2020	2021	2022
January – March	Normal	Below Normal	Above Normal	Above Normal	Normal	Normal	Normal
April – June	Below Normal	Normal	Normal	Above Normal	Normal	Below Normal	Normal
July – September	Much Below Normal	Normal	Much Above Normal	Normal	Much Below Normal	Much Above Normal	Below Normal
October - December	Below Normal	Normal	Much Above Normal	Normal	Normal	Above Normal	TBD

BRIDE BROOK, EAST LYME CT

Bride Brook

Reference Site: Pendelton Hill Brook



LONG TERM SITES

Since 2016

- **Bunnell Brook, Burlington**

Since 2017

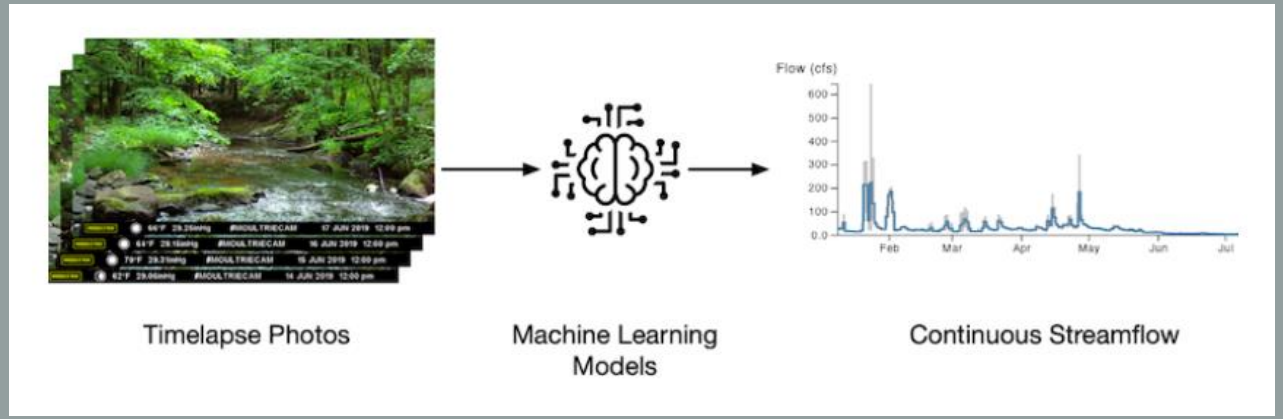
- **Cobble Brook, Kent**
- **Bride Brook, East Lyme**

Since 2018

- **Pendleton Hill Brook, North Stonington**
- **East Branch Eightmile River, Lyme**
- **Hubbard River, Hartland**
- **West Branch Salmon Brook, Granby**
- **Mount Hope River, Ashford**
- **Brown Brook, Canaan**

[Monitoring Stream Connectivity with Trail Cameras Project Summary 2016 - 2020]

AUTOMATED IMAGE VISUALIZATION, PROCESSING AND CLASSIFICATION

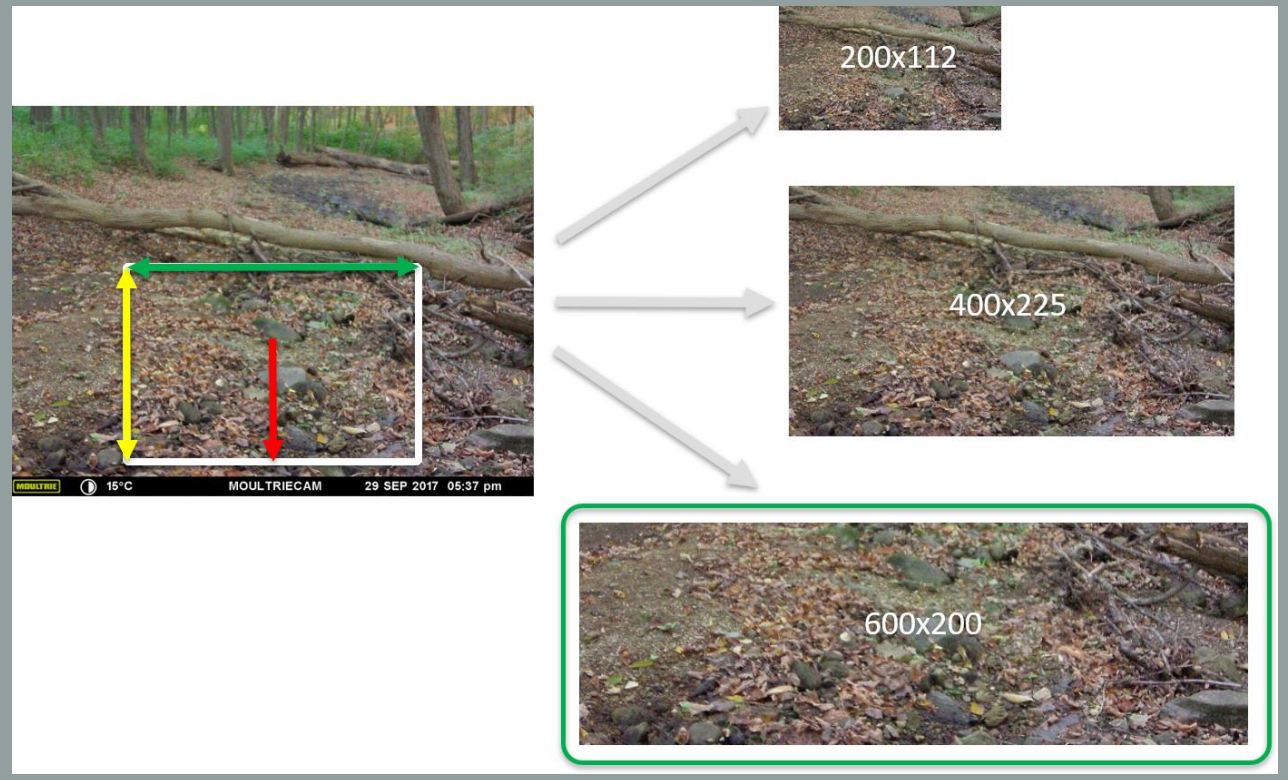


USGS Flow Photo Explorer:

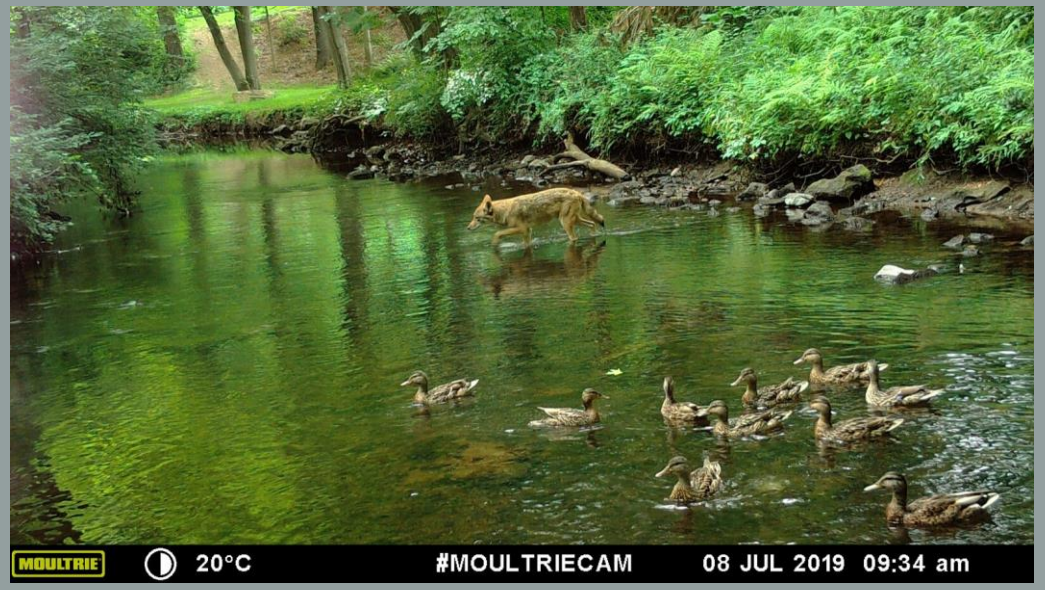
[Flow Photo Explorer | USGS]

Connecticut College:

[A framework for river connectivity classification using temporal image processing and attention based neural networks]



BONUS WILDLIFE IMAGES!



ACKNOWLEDGMENTS

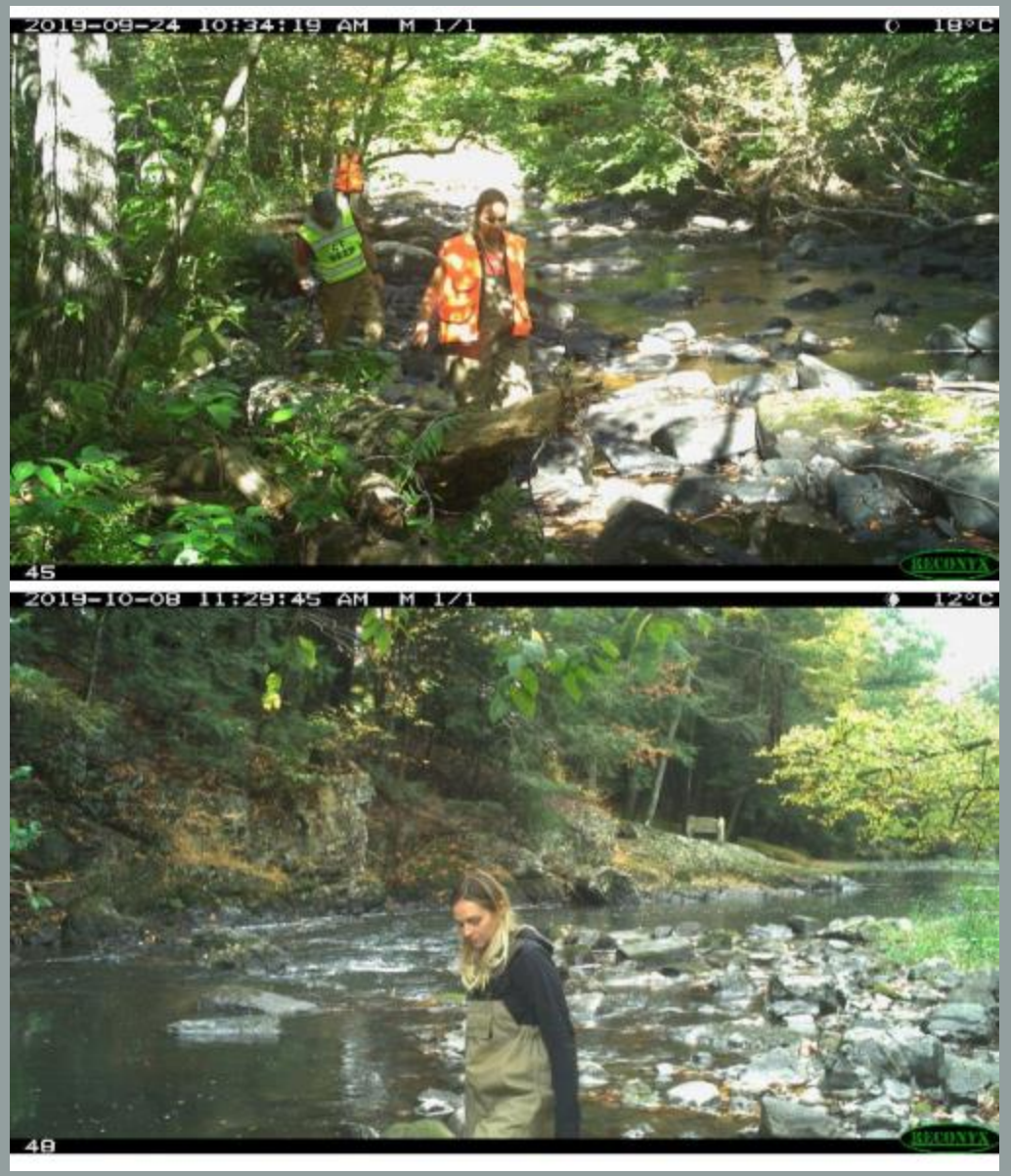
Thanks to…

CT DEEP Water Monitoring and Water Quantity field assistants and program staff

U.S. EPA Region 1 for providing equipment that aids in the collection of data for this study

U.S. EPA and USGS for providing support that aids in visualization and analysis of the data

Connecticut College Informatics Lab for providing research support for image processing and model development



QUESTIONS?

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https://portal.ct.gov/deep/water/inland-water-monitoring/stream-connectivity-monitoring